CLAIMS

1. A semiconductor device comprising:

a semiconductor substrate having a top surface and a back surface, wherein the back surface is opposite to the top surface;

a source region of a first conduction type, which extends in the substrate perpendicularly from the top surface;

a base region of a second conduction type, which extends perpendicularly from the top surface, wherein the base region has a first surface and a second surface, the second surface being opposite to the first surface, wherein the first surface of the base region contacts the source region;

a drift region of the first conduction type, wherein the drift region has an impurity concentration lower than that of the source region and extends perpendicularly from the top surface and contacts the second surface of the base region;

a drain region extending perpendicularly from the top surface in the drift region;

a gate insulating film formed on a surface that defines a trench, wherein the gate insulating film extends perpendicularly from the top surface and extends in a lateral direction from the source region to the drift region through the base region; and

a gate electrode formed on a surface of the gate insulating film such that, when a voltage is applied to the gate electrode, a channel region is generated in the vicinity of a surface of the base region adjacent to the trench, wherein the flow of the channel occurs in the lateral direction.

2. The semiconductor device of claim 1, wherein the drain region is an epitaxially grown layer of the first conduction type in which two opposed parts of the grown layer have met one another.

3. The semiconductor device of claim 1, wherein the drain region, the drift region, and the base region have substantially homogeneous impurity concentrations in the perpendicular and the lateral directions.

4. The semiconductor device of claim 1 further comprising a metal layer, which is embedded at a boundary between the source region and the base region to electrically connect the source region and the base region.

5. The semiconductor device of claim 1 further comprising:

a first metal layer extending perpendicularly from the top surface to approximately the depth of the drain region at a boundary between the source region and the base region to electrically connect the source region and the base region; and

a second metal layer extending perpendicularly in the drain region from the top surface to approximately the depth of the drain region.

6. The semiconductor device of claim 1 further comprising a metal film formed on the back surface to electrically connect the source region and the base region.

7. The semiconductor device of claim 1, wherein the base region, the drift region, the drain region, the gate insulating film, and the gate electrode are parts of a cell, and the cell is one of a plurality of similar cells, and a drain electrode is connected to the drain region of each cell to form a plurality of transistors in a chip.

8. A semiconductor device comprising:

a semiconductor substrate, which forms a source region of a first conduction type, wherein the semiconductor substrate has a top surface and a back surface, wherein the back surface is opposite to the top surface;

a base region of a second conduction type, wherein the base region extends perpendicularly from the top surface in the substrate;

a drift region of the first conduction type, wherein the drift region has an impurity concentration lower than that of the source region and extends perpendicularly from the top surface within the base region;

a drain region extending perpendicularly from the top surface within the drift region;

a gate insulating film formed on a surface that defines a trench, wherein the gate insulating film extends perpendicularly from the top surface and extends in a lateral direction from the source region to the drift region through the base region; and

a gate electrode formed on a surface of the gate insulating

film such that, when a voltage is applied to the gate electrode, a channel region is generated in the vicinity of a surface of the base region adjacent to the trench, wherein the flow of the channel occurs in the lateral direction.

9. The semiconductor device of claim 8, wherein the drain region is an epitaxially grown layer of the first conduction type in which two opposed parts of the grown layer have met one another.

10. The semiconductor device of claim 8, wherein the drain region, the drift region, and the base region have substantially homogeneous impurity concentrations in the perpendicular and the lateral directions.

11. The semiconductor device of claim 8 further comprising a metal layer, which is embedded at a boundary between the source region and the base region to electrically connect the source region and the base region.

12. The semiconductor device of claim 8 further comprising:

a first metal layer extending perpendicularly from the top surface to approximately the depth of the drain region at a boundary between the source region and the base region to electrically connect the source region and the base region; and

a second metal layer extending perpendicularly in the drain region from the top surface to approximately the depth of the drain region.

13. The semiconductor device of claim 8 further comprising a metal film formed on the back surface to electrically connect the source region and the base region.

14. The semiconductor device of claim 8, wherein the base region, the drift region, the drain region, the gate insulating film, and the gate electrode are parts of a cell, and the cell is one of a plurality of similar cells, and a drain electrode is connected to the drain region of each cell to form a plurality of transistors in a chip.

15. A semiconductor device comprising:

a semiconductor substrate having a top surface and a back surface, wherein the back surface is opposite to the top surface;

a source region of a first conduction type, which extends in the substrate perpendicularly from the top surface;

a base region of a second conduction type, which extends perpendicularly from the top surface, wherein the base region has a first surface and a second surface, the second surface being opposite to the first surface, wherein the first surface of the base region contacts the source region;

a drift region of the first conduction type, wherein the drift region has an impurity concentration lower than that of the source region and extends perpendicularly from the top surface and contacts the second surface of the base region;

a drain region extending perpendicularly from the top surface

in the drift region;

a gate insulating film formed on a surface that defines a trench, wherein the gate insulating film extends perpendicularly from the top surface and extends in a lateral direction from the source region to the drift region through the base region;

a gate electrode formed on a surface of the gate insulating film; and

at least one RESURF layer of the second conduction type, wherein the RESURF layer extends perpendicularly from the top surface in the drift region such that, when a voltage is applied to the gate electrode, a channel region is generated in the vicinity of a surface of the base region adjacent to the trench, wherein the flow of the channel occurs in the lateral direction.

16. The semiconductor device of claim 15, wherein the drain region, the drift region, the base region, and the RESURF layer have homogeneous impurity concentrations in the perpendicular and the lateral directions.

17. The semiconductor device of claim 15, wherein the RESURF layer is one of a plurality of RESURF layers, which are formed to completely deplete the drift region with depletion layers formed respectively about the RESURF layers when the voltage is not applied to the gate electrode.

18. The semiconductor device of claim 15, wherein the RESURF layer contacts the base region.

19. A semiconductor device comprising:

a semiconductor substrate, which forms a source region of a first conduction type, wherein the semiconductor substrate has a top surface and a back surface, wherein the back surface is opposite to the top surface;

a base region of a second conduction type, wherein the base region extends perpendicularly from the top surface in the substrate;

a drift region of the first conduction type, wherein the drift region has an impurity concentration lower than that of the source region and extends perpendicularly from the top surface within the base region;

a drain region extending perpendicularly from the top surface within the drift region;

a gate insulating film formed on a surface that defines a trench, wherein the gate insulating film extends perpendicularly from the top surface and extends in a lateral direction from the source region to the drift region through the base region;

a gate electrode formed on a surface of the gate insulating film; and

at least one RESURF layer of the second conduction type, wherein the RESURF layer extends perpendicularly from the top surface in the drift region such that, when a voltage is applied to the gate electrode, a channel region is generated in the vicinity of a surface of the base region adjacent to the trench, wherein the flow of the channel occurs in the lateral direction.

20. The semiconductor device of claim 19, wherein the drain region, the drift region, the base region, and the RESURF layer have homogeneous impurity concentrations in the perpendicular and the lateral directions.

21. The semiconductor device of claim 19, wherein the RESURF layer is one of a plurality of RESURF layers, which are formed to completely deplete the drift region with depletion layers formed respectively about the RESURF layers when the voltage is not applied to the gate electrode.

22. The semiconductor device of claim 19, wherein the RESURF layer contacts the base region.

23. A method for manufacturing a semiconductor device comprising steps of:

providing a semiconductor substrate, which forms a source region of a first conduction type and has a top surface and a back surface, wherein the back surface is opposite to the top surface;

forming a first trench to extend perpendicularly from the top surface in a predetermined area of the top surface;

depositing a base region film for forming a base region of a second conduction type on a surface defining the first trench to partially fill the first trench;

depositing a drift region film for forming a drift region of the first conduction type on the base region film in the first trench

to further partially fill the first trench;

depositing a drain region film for forming a drain region of the first conduction type on the drift region film in the first trench;

polishing the base region film, the drift region film, and the drain region film;

forming a second trench extending perpendicularly from the top surface and extending laterally from the source region to the drift region through the base region;

forming a gate insulating film on a surface defining the second trench; and

forming a gate electrode on a surface of the gate insulating film.